Patent claims

1. An imaging method for simultaneously determining in vivo distributions of bioluminescent and/or fluorescent markers and radioactive markers at identical projection angles, the distribution of the bioluminescent and/or fluorescent markers being determined by separate detection of photons having a first average energy, which are emitted by the bioluminescent and/or fluorescent markers, by means of at least one first detector and the distribution of the radioactive markers being determined by simultaneous separate detection of photons having a second average energy, which are emitted by the radioactive markers, by means of at least one second detector.

2. The imaging method as claimed in claim 1, characterized in that the photons of the bioluminescent and/or fluorescent markers having the first average energy and the photons of the radioactive markers having the second average energy are separated for the separate detection with the aid of a layer (5), the layer (5) essentially reflecting or transmitting the photons in a manner dependent on their energy.

3. The imaging method as claimed in claim 2, characterized in that the layer (5) serves for reflecting the photons of the bioluminescent and/or fluorescent markers in the direction of the at least one first detector and for transmitting the photons of the radioactive markers in the direction of the at least one second detector.

4. The imaging method as claimed in one of claims 1 to 3, characterized in that the bioluminescent and/or fluorescent markers comprise at least one marker from the group consisting of the markers of the luciferase reporters, the marker molecules having emission wavelengths in the near infrared range (NIRF molecules) and the molecules of the GFP (green fluorescent protein).

5. The imaging method as claimed in one of claims 1 to 4, characterized in that the radioactive markers comprise at least one marker from the group As-72, Br-75, Co-55, Cu-61, Cu-67, Ga-67, Gd-153, I-123, I-125, I-131, In-111, Ru-97, Tl-201, Tc-99m and Xe-133.

6. The imaging method as claimed in one of claims 1 to 5, characterized in that the detection of the photons having the first average energy is carried out by means of at least one CCD camera (1, 2; 38) and the detection of the photons

having the second average energy is carried out by means of at least one single photon emission computer tomography (SPECT) detector (3) comprising a collimator with at least one aperture (7).

7. An imaging method for alternately determining in vivo distributions of bioluminescent and/or fluorescent markers and in vivo distributions of radioactive markers by means of a common measurement setup at identical projection angles, the distribution of the bioluminescent and/or fluorescent markers being determined by separate detection of photons having a first average energy, which are emitted by the bioluminescent and/or fluorescent markers, by means of at least one first detector and, alternately with respect thereto, the distribution of the radioactive markers being determined by separate detection of photons having a second average energy, which are emitted by the radioactive markers, by means of at least one second detector.

8. An apparatus for carrying out the imaging method as claimed in one of claims 1 to 7, containing at least one CCD camera (1, 2, 38) at 1st detector, at least one single photon emission computer tomography (SPECT) detector (3) as second detector and a layer (5), which essentially reflects the photons of the bioluminescent and/or fluorescent markers and essentially transmits the photons of the radioactive markers.

9. The apparatus as claimed in claim 8, characterized in that the at least one SPECT detector (3) comprises a scintillation crystal array (13) with a multiplicity of scintillation crystals and a spatially resolving photomultiplier array (14).

10. The apparatus as claimed in either of claims 8 and 9, comprising two cooled CCD cameras (1, 2; 38) facing one another, a SPECT detector (3) arranged perpendicular to the CCD cameras (1, 2, 38), a shielding (4) arranged in front of the SPECT detector (3) and bent at an angle of 90°, and a layer (5) fixed on the shielding (4) and likewise bent at an angle of 90°, the bending edge (6) of said layer lying on the bending edge of the shielding (4), the layer (5) covering an aperture (7) in the shielding (4) and largely reflecting the photons emitted by the bioluminescent and/or fluorescent markers and largely transmitting the photons emitted by the radioactive markers.

11. The apparatus as claimed in either of claims 8 and 9, comprising two cooled CCD cameras (1, 2; 38) oriented parallel and oppositely to one another between two SPECT detectors (19, 20) facing one another and two masks (23, 24)

with at least two apertures (7) in each case, a respective layer (5) being situated in front of the SPECT detectors (19, 20), said layer largely reflecting the photons emitted by the bioluminescent and/or fluorescent markers and largely transmitting the photons emitted by the radioactive markers.

12. The apparatus as claimed in claim 11, characterized in that the layer (5) diffusely reflects the photons emitted by the bioluminescent and/or fluorescent markers.

13. The apparatus as claimed in either of claims 8 and 9, comprising two cooled CCD cameras (1, 2; 38) oriented in the same direction and spaced apart from one another, two SPECT detectors (19, 20) arranged perpendicular to the CCD cameras (1, 2; 38), two masks (23, 24) with at least two apertures (7) in each case and two lenses (25, 26) between the two SPECT detectors (19, 20), two reflectors (27, 28) essentially comprising a layer (5), which are oriented in such a way that they largely reflect, in the direction of the CCD cameras (1, 2), the photons that are emitted by the bioluminescent and/or fluorescent markers, transmitted through the apertures (7) in the masks (23, 24) in the direction of the SPECT detectors (19, 20) and focused by the lenses (25, 26).

14. The apparatus as claimed in claim 13, comprising a position sensor (35) for determining the current position of a subject to be examined.

15. The apparatus as claimed in either of claims 13 and 14, characterized in that the masks (23, 24), during a measurement, can be moved out of the fields of view of the CCD cameras (1, 2; 38) (position B) and can be moved into the fields of view (position A).

16. The apparatus as claimed in one of claims 10 to 15, characterized in that the aperture (7) is a countersunk elongate opening.

17. The apparatus as claimed in either of claims 8 and 9, comprising a cooled CCD camera (38), a SPECT detector (3) arranged perpendicular to the CCD camera (38), a shielding (4) arranged in front of the SPECT detector (3) and bent away at an angle of 90°, and a reflective layer (5) fixed on the shielding (4) and likewise bent at an angle of 90°, the bending edge (6) of said layer lying on the bending edge of the shielding (4), the reflective layer (5) covering an aperture (7) in the shielding (4), the SPECT detector (3), the shielding (4) together with reflective layer (5) and aperture (7) and also mirrors (45) and laser coupling-in

arrangements (43) being accommodated on a platform (41) formed in displaceable fashion.

18. The apparatus as claimed in claim 17, characterized in that the displaceable platform (41) is arranged on a mounting support (42) formed in rotatable fashion.

19. The apparatus as claimed in claim 17, characterized in that separate fields of view of the reflective layer (5) are imaged in a manner adjoining one another by means of an arrangement of mirrors (39, 40, 45) in the objective of the CCD camera (38).

20. The apparatus as claimed in claim 17, characterized in that laser beam coupling-in arrangements (43) and also mirrors (45) that are transmissive on one side are accommodated opposite one another on the displaceable platform (41) in order to excite NIRF markers in the object (8) by means of laser beams.

21. The use of an imaging method as claimed in one of claims 1 to 7 for in vivo studies on small animals, for in vivo observation of gene expression and for breast, prostate, skin tumor and thyroid gland imaging.